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SHOCK

Shock frequently follows crushing injuries, loss of blood, dehydration, pain, fear and severe toxemia. It may be defined as the clinical condition characterized by progressive loss of circulating blood volume due to generalized increase in capillary permeability.

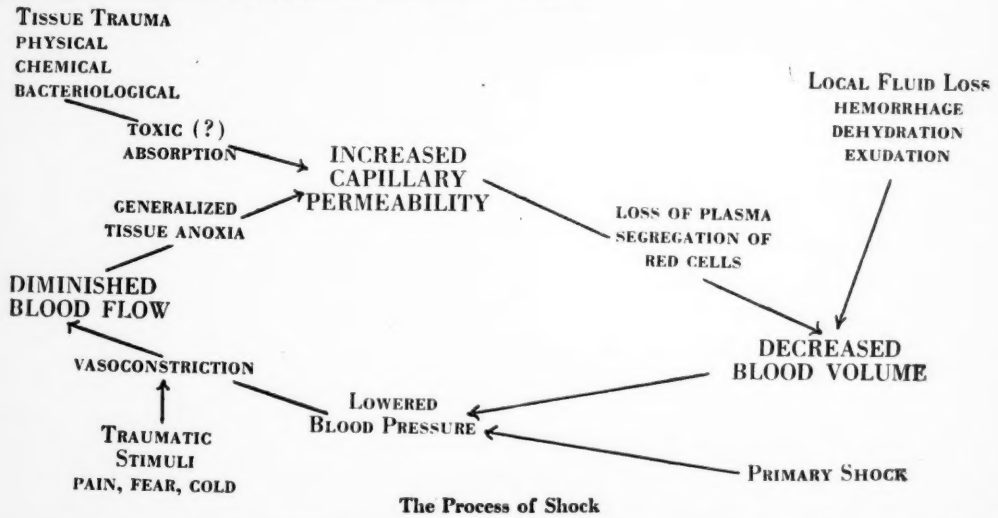
Two explanations have been advanced to account for this widespread change in capillary permeability: first, that it results through the action of some toxic factor absorbed from the area of injury and second, that the increase in capillary permeability is caused by the tissue anoxia which results from reduced circulation.

The "toxemia" theory is a very plausible concept in that the generalized increase in capillary permeability is held analogous to the wheal which results from capillary injury due to the local action of any one of a number of capillary poisons. This theory, however, suffers from the fact that no toxin capable of causing an increase in capillary permeability has yet been discovered in the circulating blood. It is again weakened by the fact that the changes observed could also be explained on the basis of the reduced circulation which is present.

Reduced circulation is consistently observed both in clinical and experimental shock. The degree of reduction in circulation is proportional to the severity of the shock. Since it has been shown that an increase in capillary permeability can be produced by the tissue anoxia which results from reduced circulation and since a severe reduction in circulation is a constant finding in shock, it is only natural to ascribe to that reduced circulation the physiological and pathological changes characteristic of shock.

Recent experiments, however, have shown that a loss of blood volume occurs after trauma in spite of the maintenance of an adequate circulation. This loss of blood volume was found to be greater than could be accounted for by the loss of fluid into the traumatized area. It occurred in spite of excluding the nervous factor by using dogs after recovery from total sympathectomy or high spinal cord transection. It was probably due to a generalized increase in capillary permeability since it was associated with hemoconcentration and characteristic pathological changes in the viscera. As a result of these observations it is our belief that the generalized increase in capillary permeability characteristic of shock may be brought about by either traumatic toxemia or reduced circulation.

Shock is a process rather than a static condition. Its mechanism is illustrated in the accompanying diagram.



The Process of Shock

The process of shock may be initiated by any one of four means: A. local fluid loss, B. primary fall of blood pressure, C. reflex vasoconstriction or D. through toxic absorption.

A. *Direct loss of blood volume* through hemorrhage, dehydration or exudation is probably the single most important cause of shock in man. It should be emphasized that the loss of blood or body fluids need not be external. Very large quantities of blood or plasma may be lost from the circulation into regions of trauma or inflammation such as the tissue spaces or intestinal tract.

B. *"Primary shock"* is the term which has been applied to low blood pressure without concomitant

loss of blood volume. This condition may arise from reflex inhibition of cardiac or vasomotor tone or from pooling of blood on the venous side of the circulation. Syncope and the fall of blood pressure from spinal anesthesia are common examples of this condition.

C. *Traumatic stimuli* may produce shock or aggravate the condition, if present, through reflex vasoconstriction. This constriction takes place in the arterioles and is essentially a protective mechanism designed to maintain the pressure in the larger arteries. However, this arteriolar vasoconstriction results in a decrease in peripheral blood flow.

Diminished blood flow, whether brought about by a fall in blood pressure or caused by reflex vasoconstriction leads to tissue anoxia, and as a result, the generalized increase in capillary permeability characteristic of shock may be produced.

D. *Toxic absorption* may be an additional factor in bringing about this change in capillary permeability. The hypothetical toxin, however, has yet to be identified. In the treatment of shock, the possibility of toxic absorption should be considered and means adopted to reduce it to a minimum.

Sustaining factors become significant once the process of shock has been initiated. These factors act in such a way as to interfere further with the circulation of blood to the tissues.

Low blood pressure may lead to a diminished coronary circulation with consequent impairment of blood supply to the heart muscle. Cardiac weakness may thereby result and this failure of the central driving force may contribute further to the circulatory collapse.

Hemoconcentration, which results from a greater loss of plasma than red blood cells, causes an increase in the viscosity of the blood. This increase in viscosity interferes still further with the passage of blood through the finer vessels.

Prevention of shock requires anticipating its occurrence. It is now well known that certain conditions such as severe burns, abdominal distention and crushing injuries of the extremities are associated with massive loss of plasma from the circulation. Replacement of this loss by the transfusion of plasma at an early stage will help to prevent the development of shock.

The following *criteria of shock* may be useful in its early recognition.

A. *Decreased peripheral circulation* is the most reliable single criterion of shock. This diminished circulation is shown by the characteristic physical findings observed in the shocked patient.

1. Grey, cyanotic pallor, especially of the face and lips.
2. Cold, clammy skin of the extremities and trunk.
3. Weak, rapid pulse of poor volume.

The thirst, anxiety and restlessness often seen following hemorrhage are symptoms of a failing circulation and presage the development of shock.

B. *Low blood pressure* is not always a reliable criterion of early shock since the blood pressure in the large arteries may be maintained by arteriolar vasoconstriction in the presence of a dangerously reduced peripheral circulation. The course of blood pressure observations is of more significance. A falling blood pressure associated with a mounting pulse rate is of serious import.

C. *Hemoconcentration* is a good index of shock only when this process is being initiated by loss of plasma or body fluid, as for example after a severe burn. When there is simultaneous loss of red blood cells, such as after crushing injuries, this criterion is not reliable. Repeated measurements of the hemoglobin concentration or hematocrit are of more value than single determinations since, in this manner, the process of shock or recovery may be more readily followed.

Treatment of shock should be directed toward the restoration and maintenance of an adequate circulation to the body tissues.

1. *Transfusion* of blood or plasma to replace that lost through hemorrhage or exudation is the most effective means of restoring the circulation. Intravenous injection of glucose and saline solutions should be used to correct dehydration and are useful in the emergency treatment of shock. It should be remembered, however, that capillary damage permits the escape of plasma containing colloids from the circulation. It is the osmotic pressure of the plasma colloids which keeps fluids in the circulation. If plasma has been lost, it cannot be replaced simply by the administration of water with electrolytes. Fluid containing colloid is required. In cases of shock, where the circulation has been depressed for a considerable time, the capillaries are damaged by the anoxia. Injection of solutions of glucose or saline, instead of restoring the blood volume, may allow still further loss of plasma protein with consequent impairment of circulation.

2. *Stimulants* are of little use in the treatment of secondary shock. The rise of blood pressure produced by the administration of camphor, caffeine, strychnine, adrenalin and related compounds is only temporary and is associated with vasoconstriction which causes further reduction in circulation to the tissues.

3. *Warmth* is a time-honored remedy in the treatment of shock but excessive heat should be avoided. The metabolic demands of the tissues are increased by any rise in temperature and the circulatory needs thus increased. In addition, further loss of body fluid may occur through sweating.

4. *Morphine* should be given except in cases of head injury in sufficient quantities to relieve pain. Sedatives are useful to relieve anxiety and restlessness but they should be used only in small quantities since they probably interfere with tissue respiration.

5. *Rest* is essential for the patient in shock and this rest should be mental as well as physical. Immobilization of the injured part helps to prevent fluid loss at the site of trauma. It is also helpful in diminishing the pain and the other harmful nervous stimuli coming from the injured area. Finally, it probably decreases the absorption of whatever toxic factors may have been elaborated at the site of trauma.

The use of adrenal-cortical hormone in the prevention and treatment of shock has not yet been sufficiently established to warrant its use.

Time is required for the process of recovery and the amount of time depends upon the duration and severity of the reduction in circulation. Transportation, manipulation and operative procedures should be postponed until recovery has taken place unless continued bleeding demands interference.

Recovery from shock may best be judged by the restoration of circulation to the peripheral tissues. When the pulse becomes of good volume, even though its rate is still high, when the normal warmth returns to the skin and the cyanosis and sweating disappear, then the blood flow to the tissues is adequate and the process of shock has been interrupted.

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Erratum:—In the article by Dr. Samuel A. Levine in the May 1942 issue on "The Prognosis of Coronary Occlusion" — Part I, the sentence beginning on the fourth line of the section dealing with the influence of fever should read "The immediate mortality of the former was 29% and of the latter 71%."